WHAT IS CLAIMED IS:

1. A reactor for reacting at least a first fluid comprising a first reactant and a second fluid comprising a second reactant, and mixing a diluent fluid with one or more portions of first fluid, second fluid and products of their reaction to form a reaction product, the reactor comprising:

a duct having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second transverse directions defining a plane through an axial location, with the area of the plane within the inner surface of the duct defining a cross-sectional area of the duct at the axial location;

a reactant distribution portion comprising at least one reactant tubular portion having an inner surface and an outer surface, the inner surface defining a first flow path for the first fluid, and having a plurality of reactant distribution orifices extending from the inner surface to the outer surface, the plurality of reactant distribution orifices having a density distribution being the locally averaged spatial density of orifices per duct cross-sectional area, and having a size distribution, the distributions being with respect to at least one of the transverse directions;

a diluent distribution portion comprising at least one diluent tubular portion having an inner surface and an outer surface, the inner surface defining a first diluent flow path for the diluent, and a plurality of diluent orifices extending from the inner surface to the outer surface of the diluent tubular portion, the plurality of diluent orifices having a density and a size distribution, the distributions being with respect to at least one of the transverse directions;

a reactant delivery system for supplying the first fluid to the reactant distribution portion;

a second fluid delivery system for supplying at least a portion of the second fluid to the duct, wherein the duct defines a second flow path for the second fluid;

a diluent delivery system for supplying at least a portion of diluent to the diluent distribution portion;

a controller for controlling the delivery of the first fluid, the second fluid and the diluent fluid to the reactor; and

wherein the density and size distribution, with respect to at least one of the transverse directions, of the diluent orifices and of the reactant orifices are configured such that the distribution of at least one of the composition, temperature, pressure and velocity of the reaction product, is controlled in the at least one transverse direction in a cross section of the duct near the reactor exit, taken along a direction transverse to the duct axis.

2. The reactor of claim 1 further comprising numerous delivery regions wherein the spacing of at least two nearby distribution orifices, the distance to an adjacent tubular distribution portion in a transverse direction, and a similar distance selected in an axial downstream direction define the delivery region about at least one orifice, wherein the delivery of fluid through that orifice is controlled within that delivery region.

3. The reactor of claim 2 wherein the distribution of the ratio of first reactant to second reactant is controlled in a direction transverse to the duct axis by controlling the delivery of the first reactant relative to the flow of the second reactant within numerous regions within the duct.

4. The reactor of claim 2 wherein the defined delivery regions comprise at least one reactant orifice and one diluent orifice each of which deliver fluid into one or more delivery sub-regions within the delivery region.

5. The reactor of claim 4 wherein a delivery sub-region is further controlled to be diluent richer with a higher diluent to first reactant ratio, compared to another delivery sub-region controlled to be diluent leaner having a lower diluent to first reactant ratio.

6. The reactor of claim 5 wherein at least one of the diluent leaner sub-regions comprises a combustible mixture.

7. The reactor of claim 1 further comprising delivery regions having diluent compositions less than a quench composition of first reactant, second reactant and diluent at a given temperature, where a greater diluent composition than the quench composition will quench the reaction to below the self sustaining rate at that temperature.

8. The reactor of claim 1 wherein the total amount of diluent delivered to the reactor exceeds the quench composition for a premixed composition with the total first reactant and total second reactant delivered to the reactor.

9. The reactor of claim 8 wherein the amount of diluent delivered to spatial sub-regions as defined by at least two adjacent diluent fluid distribution orifices and the distance to an adjacent tubular diluent distribution portion are either above or below the thermal quench limit.

10. The reactor of claim 9 wherein the diluent delivered to at least one delivery region is below 100% and greater than about 68% of the quench composition for the first and second reactants for that specified region.

11. The reactor of claim 9 wherein the diluent delivered to at least one delivery sub-region within a delivery region between tubular distribution portions is below 100% and greater than about 68% of the quench composition for the first and second reactants for that specified sub-region.

12. The reactor of claim 9 wherein the reactible delivery sub-regions with delivered diluent amounts below the quench composition concentration within that region are interspersed with non-reactible delivery sub-regions with delivered diluent amounts above the quench composition concentration.

13. The reactor of claim 12 wherein the reactable delivery sub-regions comprise evaporated diluent below the quench composition concentration plus liquid diluent which evaporates after the start of the reaction.

14. The reactor of claim 1 wherein at least a portion of at least part of the diluent delivery portion is positioned upstream of the first reactant delivery portion in the reactor.

15. The reactor of claim 14 wherein a portion of the diluent is evaporated prior to the location of onset of rapid reaction between the first and second reactants.

16. The reactor of claim 1 wherein the diluent orifice distribution is configured such that all of the diluent is evaporated prior to a specified distribution of evaporation axial distance in a direction transverse to the duct axis.

17. The reactor of claim 1 wherein the one or more of the distribution of diluent orifice size, diluent density, differential delivery pressure across the orifices, and tubular portion gap are configured so that all of the diluent is evaporated prior to the specified evaporation distance distribution.

18. The reactor of claim 1 wherein the standard deviation of the prescribed first fluid distribution varies by less than 15% of mass flow over 80% of the duct cross-sectional area.

19. The reactor of claim 1, further comprising at least one tubular portion, each tubular portion having one effective outer surface and a plurality of inner walls defining a plurality of flow paths for a liquid or gaseous fluid of either the reactant fluid or the diluent fluid.

20. The reactor of claim 1 wherein diluent fluid and reactant fluid are delivered through at least two or more passages.

21. The reactor of claim 1 further comprising an igniter configured to ignite a reaction between the first fluid and the second fluid.

22. The reactor as in claim 1 wherein the at least one tubular portion of the reactant distribution portion is located adjacent the at least one diluent tubular portion of the diluent distribution portion to provide temperature control of at least a portion of the reactant distribution portion.

23. The reactor of claim 22 wherein at least a portion of at least one diluent tubular portion is configured near at least a portion of the at least one reactant distribution portion, wherein constraining the temperature of the first second fluid and wherein reducing undesired reaction products from occluding the reactant orifices.

24. The reactor of claim 1 wherein the transverse distribution of orifice orientation of the diluent orifices are configured to control the distribution of diluent delivery in at least one transverse direction.

25. The reactor of claim 1 wherein the diluent orifices have a cone angle having an inward or outward orientation and the transverse distribution these cone angles in at least one of the transverse directions is varied.

26. The reactor of claim 1 further comprising at least one heat exchange system in the reactor.

27. The reactor of claim 1 wherein the heat exchange wall further comprises one or more of an insulating layer, a perforated radiation shield, one or more radiation shields, operable to control the heat transfer properties of the wall, one or more of the thermal

resistance of an insulating layer, the degree of perforation of the perforated radiation shield, and the distribution of the number of radiation shields, being configured to control the heat transfer between the energetic fluid and the heat exchange wall.

28. The reactor of claim1 wherein the reactor system further comprises narrow passages between one or more of diluent tubular portions downstream of formation of a reactible mixture of first fluid and second fluid within the fluid duct the narrow passages sized to be operable to constrain a flame from propagating upstream of narrow passages.

29. The reactor of claim 1 wherein the duct further comprises a diffuser positioned at least partially upstream of the reactant distribution portion wherein reducing the velocity of the second fluid.

30. The reactor of claim 29 wherein the diffuser comprises a plurality of flow splitter vanes configured to form a plurality of diffuser passages affecting the velocity of second fluid flow therein.

31. The reactor of claim 29 wherein the plurality diffuser passages are configured to achieve a desired transverse distribution of an axial mass flow rate of the second fluid in at least one of the transverse directions downstream of the diffuser.

32. The reactor of claim 29 wherein the desired transverse second fluid distribution is uniform.

33. The reactor of claim 29 wherein the desired transverse second fluid distribution is higher near walls of the duct downstream of the diffuser as compared to the center of the duct.

34. The reactor of claim 29 configuring the plurality of diffuser passages are configured to achieve a transverse distribution of the axial mass flow rate in the duct wherein the standard deviation of the axial mass flow rate is less than 15 % of a prescribed transverse distribution of the axial mass flow rate, evaluated in a duct cross section downstream of the diffuser and upstream of the start of reaction.

35. The reactor of claim 29 wherein each of the plurality of diffuser passages define an inlet area and an outlet area and wherein the ratios of the outlet area to the inlet area of each of diffuser passages are configured to reach a desired transverse distribution of an

axial mass flow rate of the second fluid in at least one of the transverse directions downstream of the diffuser.

36. The reactor of claim 29 wherein each of the plurality of diffuser passages define an included angle between adjacent diffuser passage walls that is between about 4 and 14 degrees.

37. The reactor of claim 29 wherein at least a portion of the at least one diluent tubular portion are positioned substantially perpendicular to and near a downstream edge of the fluid splitter vanes forming the diffuser passages.

38. The reactor of claim 29 wherein at least a portion of the at least one diluent tubular portion are positioned substantially parallel to and near a downstream edge of the fluid splitter vanes forming the diffuser passages.

39. The reactor of claim 29 wherein at least a portion of the diluent delivery system is located downstream the exit of the diffuser and upstream of at least a portion of the fuel delivery system.

40. A method of reacting a first reactant with a second reactant and mixing a diluent fluid with at least one of the first and second reactants and a reaction product to form a product fluid; the method comprising:

providing a reactor; the reactor having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second transverse directions defining a plane through an axial location, with the area of the plane constrained within an inner surface of the reaction defining a cross-sectional area of the reaction at the axial location;

providing a first reactant delivery system to deliver a first reactant fluid comprising the first reactant to the reactor;

providing a second reactant delivery system to deliver a second reactant fluid comprising the second reactant to the reactor;

providing a diluent delivery system to deliver the diluent fluid to the reactor;

controlling the spatial delivery of the second reactant fluid into the reactor in at least one of the transverse directions;

controlling the spatial delivery of the diluent fluid into the reactor in at least one of the transverse directions; and

wherein controlling the at least one spatial distribution of the second reactant fluid and the diluent in at least one of the transverse directions controls at least one of the composition, temperature, pressure and velocity of the reaction product, in at least one transverse direction near an exit of the reactor taken in a cross section of the reactor.

41. The method of claim 40 wherein the diluent fluid comprises fluid water.

42. The method of claim 40 further including controlling the mean outlet temperature of the reactor by controlling the amount of diluent delivered through the diluent delivery system.

43. The method of claim 40 further including acoustically exciting the reacting fluid within the reactor.

44. The method of claim 43 further including exciting the fluid to at least 10 Hz.

45. The method of claim 40 further including modulating the spatial delivery of the second fluid into the reactor to reducing fluid pressure oscillation within the reactor.

46. The method of claim 40 further including modulating the spatial delivery of the diluent into the reactor to reduce pressure oscillation.

47. The method of claim 40 further including exciting the reaction electrically.

48. The method of claim 47 further including generating a flame region and exciting the flame region to at least 2 kHz.

49. The method of claim 40 further including providing a diffuser in the reactor and delivering a portion of the diluent as vapor near the diffuser exit.

50. The method of claim 40 further including providing a diffuser in the reactor and delivering a portion of the diluent as liquid near the diffuser exit.

51. The method of claim 40 wherein at least a portion of the liquid diluent delivered by the diluent delivery system remains unevaporated as it enters the reactor.

52. The method of claim 40 further including delivering liquid and vapor diluent to the reactor and wherein the liquid diluent is delivered to the reactor downstream of the vapor diluent delivery.

53. The method of claim 40 wherein the second reactant delivery system and the second reactant delivery system are configured to form interspersed combustible and non-combustible regions and further comprising providing a transverse region of combustible fluid traversing the combustible and non-combustible regions.

54. The method of claim 40 wherein the first reactant comprises oxygen containing fluid, the second reactant comprises a combustible fuel, and the diluent comprises a vaporizable liquid.

55. The method of claim 40 further including combusting the first reactant with the second reactant within the combustion chamber.

56. The method of claim 40 wherein the diluent is delivered downstream of a flame front.

57. The method of claim 40 further including controlling the evaporation of the diluent by controlling an axial velocity distribution of the diluent away from a diluent delivery system diluent along at least a first transverse direction.

58. The method of claim 40 further including controlling the evaporation of the diluent in the reactor with respect to at least one of the transverse directions.

59. The method of claim 40 further including providing a high voltage power supply to the second reactant delivery system or the diluent delivery system and generating a high voltage electric field within the reactor.

60. The method of claim 59 further including oscillating the high voltage electric fields.

61. The method of claim 40 further including providing the reactor with coolant passages and cooling at least a portion of at a portion of the reactor with diluent which is subsequently delivered to the reactor.

62. The method of claim 40 further including controlling the temperature of the energetic fluid exiting the combustor by controlling the total diluent enthalpy change independently of the flow of vaporized diluent being delivered to the combustor.

63. A fluid delivery system comprising:

a pump comprising at least one pump member that moves in a reciprocal or rotational manner to deliver a fluid with a flow delivery distribution per pump cycle, and operable of moving through a plurality of fluid delivery cycles;

a motor operationally coupled to the at least one pump member to produce said reciprocal or rotational movement; and

a controller operationally connected to the motor to control the reciprocal or rotational movement of the at least one pump member; the controller being configured to vary the temporal distribution of motor force or torque actuating the reciprocal or rotational movement of the at least one pump member within a single pump cycle so as to control the flow delivery distribution of the flow delivered by the pump wherein the controller being operable to reduce the flow delivery fluctuations relative to a sinusoidal motor actuation.

64. The fluid delivery system as in claim 63 further comprising at least one position reference sensor able to provide at least one position reference per motor cycle, and at least one motion sensor able to determine one or more of the acceleration, speed and position of the motor member, and the controller including a feed back routine that utilizes said sensors for varying the motor actuation of the reciprocal or rotational movement of the at least one pump member within the fluid delivery cycle.

65. The fluid delivery system as in claim 64 wherein the motion sensor is operable to provide at least 1,000 measurements per pump cycle.

66. The fluid delivery system as in claim 64 wherein the controller is operable to change the motor torque at least 1,000 times per second.

67. The fluid delivery system as in claim 64 wherein a motor position sensor used is operable to provide at least 2,000 measurements per pump cycle with a resolution of at least 0.05%, and the controller is operable to change the motor torque with a closed loop bandwidth of at least 2 thousand times per second.

68. The fluid delivery system as in claim 63 wherein a motor rotor has a torque to inertia ratio of at least 10,000 reciprocal seconds squared.

69. The fluid delivery system as in claim 63 wherein a motor rotor and stator are cooled using a vaporizable coolant, and the motor rotor has a ratio of torque to inertia ratio of at least 30,000 reciprocal seconds squared.

70. The fluid delivery system as in claim 63 wherein the pump is operable to deliver at least one of a reactant liquid comprising a reactant and a diluent liquid.

71. The fluid delivery system as in claim 63 wherein the pump comprises a first pump member operable to deliver a reactant liquid comprising a reactant, and a second pump member operable to deliver a diluent liquid.

72. The fluid delivery system as in claim 71 wherein the pump comprises a first pump member actuated by a first motor rotor with first motor sensors, and a second pump member actuated by a second motor rotor with second motor sensors, and wherein the controller is operable to control the motor rotors independently.

73. The fluid delivery system as in claim 70 wherein the pump is coupled to an elongated fluid distribution member comprising numerous orifices delivering the liquid into the surrounding space.

74. The fluid delivery system as in claim 73 wherein the elongated fluid distribution member is configured into a spatial array having a transverse dimension, wherein the pump is positioned within the distance of the transverse dimension of the center of the distribution array.

75. A method of designing a reactor for reacting at least two reactants diluted by a diluent to form a reaction product, the reactor comprising:

a duct having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second transverse directions defining a plane through an axial location, with the area of the plane constrained within the inner surface of the duct defining a cross-sectional area of the duct at the axial location;

a first reactant distribution portion comprising at least one tubular portion having an outer surface and an inner surface, the inner surface defining a first flow path for the first fluid, and a plurality of first fluid distribution orifices extending from the inner surface to the outer surface, the plurality of first reactant distribution orifices

having a spatial density distribution and a size distribution with respect to at least one of the transverse directions;

a diluent distribution portion comprising at least one diluent tubular portion having an outer surface and an inner surface, the inner surface defining a first diluent flow path for the diluent, and a plurality of diluent orifices extending from the inner surface to the outer surface of the diluent tubular portion, the plurality of diluent orifices having a spatial density distribution and size distribution with respect to at least one of the transverse directions;

the method comprising:

determining the desired delivery mass flow rates for a first reactant fluid comprising a first reactant, a second reactant fluid comprising a second reactant, and a diluent fluid, the fluid inlet parameters and the desired output pressure and temperature of the reaction product fluid exiting the reactor;

configuring the first reactant distribution portion;

configuring the duct which defines a second flow path for the second fluid;

determining a transverse distribution of axial velocity of the second fluid with respect to at least one of the transverse directions;

configuring the diluent distribution portion;

configuring the spatial density distribution and size distribution of the first reactant orifices with respect to at least one of the transverse directions; and

configuring the spatial density distribution and size distribution of the diluent orifices with respect to at least one of the transverse directions;

wherein achieving a desired transverse distribution, in at least one of the transverse directions, of at least one of the composition ratio of second reactant concentration to first reactant concentration, and the temperature of the product fluid, with respect to at least one of the transverse directions.

76. A method of reacting a first reactant with a second reactant and mixing a diluent fluid with at least one of the first and second reactants and a reaction product to form a product fluid; the method comprising:

providing a reactor; the reactor having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second transverse directions defining a plane through an axial location, with the area of the plane constrained within an inner surface of the reaction defining a cross-sectional area of the reactor at the axial location;

providing a first reactant delivery system to deliver a first reactant fluid comprising the first reactant to the reactor;

providing a second reactant delivery system to deliver a second reactant fluid comprising the second reactant to the reactor; the second reactant delivery system comprising a diffuser that comprises a plurality of passages;

providing a diluent delivery system to deliver the diluent fluid to the reactor;

controlling the spatial delivery of the first reactant fluid into the reactor in at least one of the transverse directions;

controlling the spatial delivery of the diluent fluid into the reactor in at least one of the transverse directions; and wherein controlling the at least one spatial distribution of the second reactant fluid and the diluent at least one of the transverse directions wherein controlling at least one of the composition, temperature, pressure and velocity of the reaction product, in at least one transverse direction near an exit of the reactor taken in a cross section of the reactor.

77. A method of accurately controlling the composition of a reaction fluid formed by a reaction between two reactant fluids, the method comprising:

delivering a first liquid reactant to a reactor through a reactant distributed contactor positioned within a duct in the reactor;

delivering a second fluid co-reactant through multiple fluid passages into the duct; the duct having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second transverse directions defining a plane through an axial location, with the area of the plane constrained within an inner surface of the reaction defining a cross-sectional area of the reaction at the axial location;

configuring the reactant distributed contactor to control the spatial delivery of the first liquid reactant into the reactor in at least one of the transverse directions; and

measuring the residual component concentration of one of the reactant and the co-reactant;

wherein the measured residual component concentration is less than 15% of the concentration of the reactant or co-reactant within the reactor upstream of the reaction;

wherein the sensor measuring the residual component concentration is operable to measure the residual component concentration with an uncertainty of less than +/-0.5% of the total flow;

measuring the mass flow rate of first reactant with an uncertainty of less than +/- 1% of the total flow;

sampling the reaction product at multiple locations across the reactor outlet sufficient to measure the residual component concentration wherein achieving an uncertainty of about +/-1% in the ratio of second reactant to first reactant.

78. The method of claim 40 further comprising controlling the delivery of diluent fluid and first reactant fluid to the reactor to control the pressure within the reactor to within the specified compressor surge boundaries above which pressure causes surge in the second reactant delivery system.

79. The method of claim 78 further comprising controlling the delivery of diluent fluid and first reactant fluid to control the pressure within the reactor to within the specified compressor surge boundaries and to control the temp of the product fluid.

80. The method of claim 78 further comprising controlling the spatial distributions of the delivery of diluent fluid and of first reactant fluid to the reactor wherein controlling the distribution of pressure within the reactor in at least one of the transverse directions to within the specified compressor surge boundaries and controlling the distribution of temperature of the product fluid in at least one of the transverse directions.

81. A method of controlling a pressurized reactor; the method comprising:

providing a reactor; the reactor having an axial direction and a first and second transverse directions mutually distinct from the axial direction, the first and second

transverse directions defining a plane through an axial location, with the area of the plane constrained within an inner surface of the reaction defining a cross-sectional area of the reaction at the axial location;

providing a first reactant delivery system to deliver a first reactant fluid comprising a first reactant to the reactor;

providing a second reactant delivery system to deliver a second reactant fluid comprising a second reactant to the reactor;

providing a diluent delivery system to deliver a diluent fluid comprising a vaporizable diluent to the reactor;

reacting a first reactant with a second reactant whereby forming a reaction product;

mixing a diluent fluid with at least one of the first and second reactants and a reaction product whereby forming a product fluid comprising a reaction product and diluent;

and controlling the delivery of diluent fluid and first reactant fluid to the reactor to control the pressure within the reactor to within specified compressor surge boundaries above which pressure causes surge in the second reactant delivery system.

82. The method of claim 81 further including controlling the temperature of the product fluid.

83. The method of claim 81 further including controlling the spatial delivery of the second reactant fluid into the reactor in at least one of the transverse directions and controlling the spatial delivery of the diluent fluid into the reactor in at least one of the transverse directions wherein controlling the at least one spatial distribution of the second reactant fluid and the diluent in at least one of the transverse directions controls at least one of the composition, temperature, pressure and velocity of the reaction product, in at least one transverse direction near an exit of the reactor taken in a cross section of the reactor.

84. The method of claim 83 further comprising controlling the spatial distributions of the delivery of diluent fluid and OF first reactant fluid to the reactor wherein controlling the spatial distribution of pressure within the reactor in at least one of the transverse directions to within the specified compressor surge boundaries, and controlling the

spatial distribution of temperature of the product fluid in at least one of the transverse directions, the spatial distributions being taken in at least one of the transverse directions.